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ADDITIONAL NOTES UPON THE BREEDING OF THE COFFEE-BEAN WEEVIL

(*Aræcerus fasciculatus* De Geer.)

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Since my paper announcing the discovery of the attacks by the coffee-bean weevil in cornstalks was submitted for publication (27), observations upon the habits and life history of the insect under different conditions have been continued whenever possible, not only by myself, but by other agents associated with me in the cotton boll weevil investigation.

As a possible injurious insect of a very important staple crop, as noted in the case of corn, the coffee-bean weevil excites special attention. While no direct proof of adverse effect upon the development of the ears can yet be charged to this weevil, the nature of its work in attacking green stalks places it in an apprehensive attitude that will need close watching.

The observations concerning the breeding of the species in cornstalks during the winter and spring months have proved conclusively that it thrives without an interruption, although a large mortality of all stages was apparently caused by cold weather. On January 25 Mr. R. A. Cushman, while at Alexandria, La., found the weevils in all stages and their work generally occurring in old standing stalks in the field of their discovery. During an examination of the same field and others in the vicinity, made by myself on February 26 and 27, most stalks showed abundant evidences of work by the insect, although at this time the ground in all but two out of five fields on as many different plantations had been broken with middle-burster plows; and,

in consequence, the stalks on the plowed lands lay in pieces either on the surface or partly buried. The results of rigorous activity was displayed with the prevalence of live larvæ and pupæ in the damp buried parts of stalks, scarcely any dead stages occurring with them. With the dry uncovered or standing stalks, however, the exposure to freezing weather had evidently resulted in a large fatality, as most of the stages, including the few adults found, were dead Among the slight survival of stages above ground the pupæ exceeded in proportionate number, thus showing a superior hardiness of this stage. Some dead adults which were taken from standing stalks seemed to have perished suddenly when just ready for emergence, their bodies, in fact, filling the exit hole. The conclusion was reached that the conditions most favorable for survival depended upon the protection of earth, such as occurred with root stalks and buried pieces.

A diligent search was made to ascertain if the boll weevil might be found hibernating in the cavities formed by *Aræcerus fasciculatus*, or otherwise in split or hollow stems. Instead of finding any boll weevils, however, other insects were taken, among which were certain weevils that are apt to be mistaken by planters and field laborers for the cotton boll weevil. These in particular were the cow-pea pod-weevil (*Chalcodermus æneus* Boh.) and a common grain weevil (*Calandra oryzæ* Linn.). The failure to find a single boll weevil in the stalks at this time does not disprove its probable choice of this form of shelter, which may reasonably be expected to harbor this pest when in close proximity to infested cotton fields. In fact, cornstalks are known to afford very favorable hibernation quarters for the boll weevil, which, following after the ravages of *Aræcerus fasciculatus,* would find retreat doubly accessible.

To determine whether similar work by *Aræcerus fasciculatus* might be carried on in other localities of Louisiana an inspection of old cornfields was made at Mansura on March 1 and 2, which resulted in finding the same kind of invasion by the insects as at Alexandria. The opinion that such infestation was likely a matter of general occurrence was sustained by Mr. W. D. Hunter, who reported as an estimate that half of the stalks which he saw in the vicinity of Mansura, six days later, showed more or less injury, and with as many as five emergence holes appearing on a joint. Subsequently Mr. W. D. Pierce, while stopping at this place on a trip of inspection April 13, observed that the weevils were breeding abundantly in the same manner as noted before.

Since the facts had now determined an infestation of more than local extent, its significance applied prospectively to a large region in

which the climate and crop conditions offered corresponding inducements to the weevil, and naturally including southern Texas. To verify the part that Texas was expected to share, Mr. J. D. Mitchell inspected a number of old cornfields at Victoria, March 7 to 10, and in every one he readily found the weevil and evidence of its work. He estimated that not over 10 per cent. at most of the stalks were attacked. All of the information so far obtained, however, positively defined this newly-known habit of the weevil as an universal trait.

That this weevil is capable of breeding indefinitely in cornstalks was shown by its continuance of stages in the first collection of stalks obtained last year, on September 18, until the experimental test was purposely terminated on April 14 of the present year, covering a period of seven months; and, moreover, the insect has proven its ability to withstand the winter climate of Dallas, Tex., where the infested stalks were kept in a breeding box in an outdoor insectary. While the species has survived severer winter weather than where collected, no protection was afforded other than a dry screened cage under a roof.

In order to learn the particulars by personal observations concerning the reported attacks in green stalks, as mentioned in my previous paper (27), an inspection of the corn growing on the same plantation near Alexandria, La., where the weevils had been first detected in the rôle of a cornstalk pest, was made on August 3 of the present year. My search required only a few minutes at any place examined to obtain abundant evidence of the weevils' presence, though, contrary to expectations based on my first experience of last year, the lower joints instead of any above the ears were found attacked. Furthermore, the astonishing feature of their work was shown by severe attacks on the leaves. Upon stripping these leaves from the stalks the inner side of the base which encircles the stem above the node was found to be shredded with burrows, generally running in courses between the fibres, the work opening through the surface on account of the thin structure.

The finding of live larvæ occupying burrows in the damaged portions of the leaves clearly places the responsibility of the work upon this stage of the insect. Moreover, an adult was taken while resting on a blade. In the joints the larvæ were found embedded just under the surface at the node, the external effect being distinguishable by a blackened spot, indicating the point of entrance or oviposition. As the attacks occurred more commonly on leaves than stalks, the inference follows that the weevils first breed in the base of the leaves and later attack the joints, probably as each in turn begins to dry. On the whole, however, the stalks were in a green and sappy condition, some

still having fresh green leaves, although no leaf was found attacked except dried ones. Of course, from the nature of the attack, such leaves would dry prematurely, and to some extent injured stalks would be similarly affected. The infestation proved to be more prevalent in corn growing on land which had produced a like crop the year before and where old stalks remained than in fields on cotton land. Besides, the time of planting made some difference in the conditions of freshness in favor of the crop on the cotton land which was planted late. On account of unusual hot and dry weather the crop matured about one month earlier this year than ordinarily. If the weevil should attack stalks as early in the season on normal years as it has this year, the yield would naturally be expected to suffer from incomplete nourishment. To all appearances, no detrimental effect on this year's product could be charged to any cause other than to weather conditions in support of the claim of undersized ears. The chain of evidence in determining the attacks in green stalks, however, is further strengthened by the maturity of weevils from infested samples placed in a breeding box. At Tallulah, La., on October 1, two adults were found on drying stalks of late planted corn. Although I failed to find any signs of breeding in the stalks, their presence was considered to be for the purpose of oviposition.

As a cotton insect Dr. L. O. Howard has placed the species on record as attacking damaged bolls, and he also points out the principal adult characters by which it can easily be distinguished from the boll weevil, since both insects in one stage or another are sometimes found living in different parts of one boll (12, 13). Its work in this respect is much like a scavenger, or, as Doctor Howard states, a "result, rather than the cause, of the damage." Field observations have failed to bring to my notice any definite evidence of its attack in green bolls. That such instances seem possible in case of partially diseased bolls was indicated by finding at Jackson, Miss., on October 11, an adult hiding in an opening of a boll in which anthracnose had developed sufficiently to cause discoloration of the exposed internal tissues; otherwise the boll was green and unaffected. The intent of this weevil was surmised to be for oviposition, and at the same time to feed upon the decaying tissues. Definite cases of its breeding in bolls have been repeatedly carried through from larva to adult, but in every instance the infested bolls were old deteriorated or dried rotten ones, the ravages occurring particularly as a sequence to the disease called anthracnose.

From collections of old cotton bolls gathered by myself at Alexandria and Mansura, La., February 26 to March 2, and by Mr. J. D.

Mitchell at Victoria, Tex., March 7 to 10, the dates being already stated for examination of cornfields, the weevil in all stages, mostly larval, however, was frequently encountered in both hanging and fallen bolls. Many of these bolls, including the seeds, were so completely riddled internally that only the burr prevented them from crumbling into dry powder. Larvæ in these bolls isolated for rearing matured as adults from March 24 until April 14. In the course of examination of the bolls from Alexandria, La., one fallen boll was found to contains a number of live mites with two dead pupæ of *Aræcerus fasciculatus.* The gregarious position of these mites within the nearly destroyed pupal bodies at once indicated their predaceous nature. These mites were identified by Mr. Nathan Banks as apparently his species, *Tyroglyphus breviceps.* This species of mite affords additional interest from the fact that it has been known at times to prey upon larvæ of cotton boll weevils in fields at Victoria and Calvert, Tex.

The persistency of *Aræcerus fasciculatus* in breeding in old cotton bolls was notably observed this year at Natchez, Miss. Mr. R. A. Cushman found all stages in dried and decayed seeds of bolls which he collected at this place on January 19. During the time of my assignment at Natchez, from May 11 until June 29, for the purpose of recording the appearance of boll weevils in hibernation experiments, adults of the coffee-bean weevil also appeared frequently with boll weevils in cages containing old plants with hanging bolls, and in one instance from Spanish moss alone in the cage. To prove that *Aræcerus fasciculatus* actually bred in the bolls at this time, an examination of a number of hanging and fallen bolls gathered from old stalks in an open space adjacent to the cages was made on June 8, and resulted in finding both larval and adult stages, many of the bolls showing severe ravages. A weevil matured in fourteen days from an infested boll placed in isolation.

An important factor which relates to the favorable propagation of the coffee-bean weevil is afforded by berries of the China tree, as formerly mentioned, (27). During my inspection work at Alexandria and Mansura, La., the overwintered Chinaberries also received attention, and the finding of larvæ commonly at work in them denoted a general infestation of the fruit. The abundance of these berries which remained hanging on the trees therefore provided an attractive medium for the breeding of the weevils. Not only as an alternative, but in case of destruction or absolute lack of cornstalks and cotton bolls, the weevil will evidently maintain a prolific multiplication in Chinaberries. Mr. J. D. Mitchell has reported the emergence of an adult weevil from a Chinaberry as early as February 28 at Victoria, Tex. On May

27, at Natchez, Miss., I found two fresh-looking adults clinging to stems of fallen berries, from which they had probably just emerged, and a young larva found at the same time in a berry selected from other infested ones matured June 17 in isolation. Few larvæ were found in old fallen berries at Tallulah, La., on October 1.

An additional food-plant, concerning which no former record is known to me, has been reported by Mr. J. D. Mitchell, who submitted an adult weevil with the statement that it emerged on February 21 from castor bean (*Ricinus communis* Linn.), collected December 21 at Victoria, Tex. At Baton Rouge, La., on April 13, Mr. W. D. Pierce obtained an adult and larva in an old rotten fig, which had been hanging on the tree, but earlier mention of the weevil's depredations in fig products has been made by Mr. E. Barlow with respect to Chinese figs, (1), and by Dr. F. H. Chittenden in regard to fig cakes, (7).

The statement previously made regarding its breeding in beans is applicable to such as possess aromatic properties. Dr. F. H. Chittenden, who bestowed the common name of "Coffee-bean weevil" upon the insect, is the leading authority upon the omnivorous habits of the pest in attacking vegetable substances, (5, 6, 7.) Being transported in tropical products the insect has become cosmopolitan as an indirect result of world-wide traffic, thus accounting for its introduction into the United States. The immature stages, as a rule, are pure white, although generally covered with the fine powdered debris of the burrow; but occasionally in the cornstalks and rarely in cotton bolls pink colored examples of both larvæ and pupæ were found.

Literature Consulted

1. **Barlow, E.** Notes on insect pests from the entomological section, Indian museum. (Indian Museum Notes, IV, No. 3, Govt. India, Dept. Rev. and Agric., 1899, pp. 125–127, pl. XI, fig. 3, larva, pupa, dorsal and side views of adult.)

   Called the areca-nut beetle from its attacks in stored nuts of *Areca catechu*, or betel-nut. Mentioned as attacking coffee-berries, ginger, Chinese figs, etc. Article ends with synonymy by Doctor Gemminger et B. de Harold, Catalogus Coleopterorum.

2. **Beutenmuller, Wm.** On the food-habits of North American Rhyncophora. (Jour. N. Y. Ent. Soc., I, 1893, p. 88.)

   Quotes Mr. E. A. Schwarz's record, see 25.

3. **Blackburn, T., and Sharp, D.** Memoirs on the Coleoptera of the Hawaiian Islands. (Sc. Trans. Royal Dublin Soc., III, ser. II, Feb., 1885, p. 260.)

   "Widely distributed. Common in decaying leaves wherever they are heaped up from any cause, and occasionally beaten from fresh

foliage. Very variable. This insect has no saltatory powers whatever."

4. **Brown, R. E.** Strychnine as food of *Aræocerus fascicularis* De Geer. (Jour. N. Y. Ent. Soc., XIV, 1906, p. 116.)
Reported breeding in the St. Ignatius bean (*Strychninos ignatii*) in the Philippines.

5. **Chittenden, F. H.** Insects affecting stored cereal and other products in Mexico. (Bull. 4, Tech. Ser., Div. Ent., U. S. Dept. Agric., 1896, p. 30.)
Mentioned as "coffee-bean weevil," with the statement that it is disposed to be omniverous, being known to breed in raw coffee-berries, cacao beans, mace, nutmegs, cotton bolls, the seed pods of the coffee weed (*Cassia*, sp.), and a plant called wild indigo, probably a species of Indigofera. Well known throughout the cotton states and sometimes found in the northern states in articles of commerce.

6. ———. Insects affecting cereals and other dry vegetable foods. (Bull. 4, n. s., Div. Ent., U. S. Dept. Agric., 1896, p 129; also Rev. Ed., 1902, p. 129.)
Name proposed as "coffee-bean weevil." Infesting dried apples, also coffee beans, mace, nutmegs, chocolate beans and roots of ginger.

7. ———. An invasion of the coffee-bean weevil. (Bull. 8, n. s., Div. Ent., U. S. Dept. Agric., 1897, pp. 36–38, fig. 9, larva, pupa and adult.)
The species found to have been introduced in a grocery store of Washington, D. C., from coffee in sacks, the insects afterwards entering boxes of dried fruits and into crackers, especially fig cakes, breeding freely in dried apples. Mentions cotton bolls as food; also all stages in dry orange from Florida. Gives reference to original spelling of generic name.

8. **Fullaway, D. T.** Insects of cotton in Hawaii. (Bull. 18, Haw. Agric. Exp. Sta., 1909, p. 24, fig. 16, larva, pupa and adult of coffee-bean weevil, from Chittenden.) Mentions the species as "found about cotton, probably seeking shelter," and quotes Dr. L. O. Howard's reference.

9. **Giffard, W. M.** Presidential address. (Proc. Haw. Ent. Soc., I, pt. 5, April 8, 1908, p. 181.) Mentioned as an introduced species. "Beaten from Kukui" (*Aleurites moluccana*).

10. **Glover, T.** Entomological record. (Monthly Rept. U. S. Dept. Agric. for August and September, 1872, p. 367, fig. 13, larva and adult.)
Referred to as *Aræocerus coffeæ* Fab. and reported breeding in decaying peaches from Baton Rouge, La.

11. ———. Report of the entomologist and curator of the museum. (Rept. U. S. Com. Agric. for 1872, p. 114, fig. 3, larva and adult.)
Reference same as 10.

12. **Howard, L. O.** The insects which affect the cotton plant in the United States. (Bull. 33, Office Exp. Sta., U. S. Dept. Agric., 1896, p. 348.)
The author in his account of the "Insects Injuring the Boll" says, "Among these the larva of a little weevil, *Aræcerus fasciculatus*, de-

serves especial mention for the reason that it so closely resembles the larva of the Mexican cotton-boll weevil."

13. ———. Insects affecting the cotton plant. (Farmers' Bull. 47, U. S. Dept. Agric., Jan., 1897, p. 29.)
Reference same as 12.

14. **Hunter, W. D., and Hinds, W. E.** The Mexican cotton boll weevil. (Bull. 45, Div. Ent., U. S. Dept. Agric, 1904, p. 49, pl. XV, fig. 62, larva, pupa and adult, from Chittenden.)
Entered in list of "Insects often mistaken for the boll weevil," under the common name of "Coffee-bean weevil," the usual food being given as "coffee beans and old cotton bolls."

15. ———. The Mexican cotton boll weevil: A revision and amplification of bulletin 45, to include the most important observations made in 1904. (Bull. 51, Bu. Ent., U. S. Dept. Agric., 1905, p. 67, pl. XI, fig. 49, larva, pupa and adult, from Chittenden.)
Reference similar to 14.

16. **Koebele, A.** Report of entomologist. (Rept. Com. Agric. and For., Ter. Hawaii, 1900, p. 43.)
"A large number of a very common beetle, *Aræocerus fasciculatus* De G., previously bred on coffee cherries from Waianae, also on seeds of koa, the mamani, and many others; even a seed pod of the kola nut produced quantities of this beetle that will breed equally as well in dead wood."

17. **Perkins, R. C. L.** Coleoptera, Rhyncophora, Proterhinidae, Heteromera and Cioidae. (Fauna Hawaiiensis, II, pt. III, Feb. 8, 1900, p. 182.)
Remarks as follows: "Hab. Abundant all over the islands in the mountains. The large number of constant varieties in markings, as well as the great variation in size of this species is remarkable."
Follows with description of *Aræocerus constans*, sp. nov.

18. ———. Injurious and beneficial insects. (Rept. Gov. Ter. Hawaii, 1902, p. 32.)
"Destroying seeds of many forest trees, e. g., koa, mamani, etc.; also in coffee berries. No natural enemies known here."

19. **Pierce, W. D.** On the biologies of the Rhyncophora of North America. (An. Rept. Neb. St. Bd. Agric. for 1906-07, p. 295.)
Refers to Mr. R. E. Brown's record, see 4, and adds: "This species has many host plants."

20. ———. A list of parasites known to attack American Rhyncophora (Jour. Econ. Ent., I, No. 6, 1908, p. 389.)
Lists the species as one of economic importance and as serving as co-host of boll weevil parasites.

21. **Riley, C. V.** Cotton culture and the insects affecting the plant at Bahia, Brazil. (Amer. Ent., III, May, 1880, pp. 128-129.)
Reports *Aræcerus fasciculatus* in cotton bolls forwarded from Bahia, Brazil, January 12, 1880.*

*A subsequent record in the entomological files of the U. S. Dept. Agric., under accession No. 2218, states that weevils matured in diseased bolls from Bahia, Brazil, November 13, 1882.

22. ———. The final report on the cotton worm, together with a chapter on the boll worm. (Fourth Rept. U. S. Ent. Com., 1885, note 62, p. [121].)

Remarks reproduced from 21.

23. ———. The insects occurring in the foreign exhibits of the World's Columbian Exposition. (Insect Life, Div. Ent., U. S. Dept. Agric., VI, February, 1894, p. 221.)

"Breeding in mace from Trinidad and Johore, and in cocoa beans from Liberia."

24. **Sanderson, E. D.** Insects injurious to cotton. (Insects Injurious to Staple Crops, 1902, pp. 200–201.)

Mentioned as attacking damaged bolls.

25. **Schwarz, E. A.** The Coleoptera of Florida. (Proc. Amer. Phil. Soc., XVII, 1878, p. 469.)

"*Aræocerus fasciculatus*—not rare, raised from the pods of a large yellow flowering shrub belonging to the Mimosaceæ."

26. **Smith, J. B.** Insects of New Jersey. (Supp. 27th An. Rept. St. Bd. Agric. N. J., 1899 [1900], p. 367.)

"Undoubtedly brought into the state on dried fruits and similar stores (Ch)."

27. **Tucker, E. S.** New breeding records of the coffee-bean weevil. (Bull. 64, pt. VII, Bu. Ent., U. S. Dept. Agric., August 5, 1909, pp 61–64, pl. III, work in cornstalks, and fig. 18, larva, pupa and adult, from Chittenden.)

Injury to corn; occurrence in Chinaberries; parasites; habits in general.

28. **Van Dine, D. L.** Report of the entomologist. (An. Rept. Haw. Agric. Exp. Sta. for 1907, p. 48.)

Under subhead of "Stored Products" the following records are given: "A beetle (*Aræocerus fasciculatus*) was bred from the seeds of St. John's bread (*Ceratonia siliqua*) received from Kohala, island of Hawaii. This same beetle was bred from cotton bolls received from Kona, island of Hawaii."

29. **Van Dine, D. L.** Report of the entomologist. (An. Rept. Haw. Agric. Exp. Sta. for 1908, p. 31.)

"A weevil (*Aræocerus fasciculatus*). This weevil was bred from cotton bolls received from Hookena, South Kona, Island of Hawaii, in December, 1905. Determined by Mr. E. A. Schwarz of the Bureau of Entomology."

NURSERY INSPECTION IN NORTH CAROLINA

By Franklin Sherman, Jr., *Entomologist, State Department of Agriculture, Raleigh, N. C.*

North Carolina does not take high rank as an orchard state, nor does she rank high in the number or average size of her nurseries. There has been an increase in the number of nurseries during the past decade. In 1900 there were forty-five licensed, in 1908 there were sixty-two licensed, but for the present season the number has dropped to fifty-six, with perhaps one or two yet to be added. Every year a few small nurserymen quit for one reason or another, and others start up. Of course our larger nurseries are permanently established and have considerable capital invested, but we probably have a larger proportion of small, temporary nurseries than is found in most states. However, this may be more apparent than real, due to the fact that we have continued the same system and policy of inspection so long that we have located and listed practically all nurseries even to the smallest ones which serve only a local trade and never offer shipments for transit by railways, etc.

We, like others, are frequently vexed to decide just "what is a nursery" and to tell whether this or that person's premises should be inspected. Often the expense and time required to make an inspection are so great as to be out of all proportion to the importance of the end served by it. In accord with the ideas which the writer has advanced at meetings of the horticultural inspectors we are constantly striving to eliminate needless inspections, needless expenses, and needless hampering of trade, as we believe that it is just such matters that cause some nurserymen to condemn the whole system of inspection as useless.

Our system of nursery inspection and control is very far from perfect. While our conditions of work are all that could be desired in almost every other particular, we are handicapped by the fact that we have only one man (Mr. S. C. Clapp of this office) to assign to the inspection work, and our funds are such that we cannot spend as much on the inspections as would be required to absolutely clinch their efficiency. We do not put a man out of business because his stock is infested with San José scale, and we state this fact plainly to our public. We destroy all trees that are seen to be infested in a *careful inspection,* and if the number is very small in comparison to the number of trees involved the nursery is certified. If the number found infested is large enough to throw suspicion on the whole lot

the block is examined *tree by tree*,—or is left over for a second inspection later, the proprietor being fully instructed what he is to do about it in the meantime. There is no charge for the one (first) regular inspection, but when second inspections are necessary there is a sizable fee, graded according to the acreage involved in difficulty, so the whole tendency is for the nurseryman to see to it that a second inspection will not be required. If a block is found to be so infested that even tree by tree inspection would still be insufficient, the block (or part of it) is condemned to complete destruction. Now right here comes a point,—how do we *know* that the condemned stock is destroyed? Well, here we are guided by circumstances. If the block is very small the inspector can cut off every tree row by row with his heavy pocket knife (which is always carried for the purpose); or he can stay on the premises while the laborers do the work of destruction by this means or otherwise. Or if the condemned block is large he may go his way and return later to see that the work has been done. If the nurseryman is one whose whole past record and conduct gives guarantee of his integrity the inspector may leave it to him to destroy the stock, the nurseryman writing us when the work has been done and we take his word for it. In case of doubt about the work having been properly done the inspector makes another visit to make sure.

It should be remembered that all stock of apple, peach, pear, plum, cherry, quince and apricot is required to be fumigated with hydrocyanic acid gas before it is sold from any nursery in the state, and all our nurseries are required to maintain suitable boxes or rooms for the fumigation, and every nurseryman is furnished with explicit printed instructions on the fumigation process, these instructions also indicating the amounts of cyanide, acid and water required for the particular box or room of the nursery to which sent. So the fumigation comes in as an additional safeguard after the other conditions have been met.

It is only in the more important cases that we arrange to have the stock fumigated personally by someone from this office. The great bulk of our nurserymen do their own fumigating, the inspector giving them any needed instructions at time of inspection. It is true that there is chance for stock to be sold without having been fumigated, but we believe that our nurserymen on the whole do reasonably well in meeting this requirement.

Now a word as to the qualifications of the inspector himself. It goes without saying that he should be able to recognize the more important insect and fungous pests that are liable to be in the nursery. We all recognize this as a prime necessity in meeting the *entomological* and *pathological* requirements of the situation. Should he not also be

well acquainted with nursery practices, customs, etc., so as to make only such demands as are practicable from the *nursery* standpoint? We all know that it is difficult to so conduct our inspections and so word our certificates that all kinds of stock shall always be properly covered by certificate,—there is so much of buying and selling, trading, dealing, one nursery growing stock for another, agents carrying over refused stock, etc., etc. I fear that those of us who make our inspections with an eye to their efficiency from the entomological viewpoint solely often make demands of our nurserymen that are well nigh impossible to meet in commercial practice. We are properly sensitive if persons in any other walk of life intrude themselves or their ideas into our affairs, for we maintain that such persons do not know what really is or is not practical in entomological work. Is there not reason for us to be careful that we in looking after the one question of insect pests do not give the nurserymen just cause to resent our inspection work? This idea has grown on the writer year by year,—while we were adhering to the custom of doing the work in person or having only technically trained assistants (college men) to do the inspection work. When it became necessary some two years ago to secure an inspector a young man was selected who had five years' actual experience in a commercial nursery, and who therefore knows the conditions of nursery work and trade, can recognize varieties in the nursery row, and is thoroughly familiar with all the practices common to the nursery business. This man was already familiar enough with San José scale to be a good inspector, and with very little further study and experience has developed into a good all-round man in nursery and orchard inspection work, spraying work, etc. It strengthens our work among the nurserymen if our inspectors show a practical familiarity with the nursery business, in addition to being expert in detecting insect and fungous troubles.

It has been our endeavor to cut out all the immaterial, unimportant details and center our efforts on the main points that are at stake in the nursery inspection, and we have tried to make both our work and its requirements more simple and more effective year by year. We find that the proportion of nurseries found to be infested by San José scale is slowly increasing, and this seems to be inevitably the case through most of the eastern states, but we can at the same time assert that the average condition of the infested nurseries is becoming better year by year.

There are a few who still regard the inspection as a mere matter of form, but they are mostly growers of ornamentals, berries, etc., to whom the inspections do not apply so exactingly, or else they are

uneducated nurserymen who have not yet been brought squarely against the scale problem. The feeling of real respect (not merely tolerance) toward the inspection work in this state was never so great as it is at present.

PLANT LOUSE NOTES, FAMILY APHIDIDAE

By C. P. Gillette

Subfamily *Lachninæ*

Phyllaphis fagi L. At Lansing I found this species extremely abundant. Large American beech trees (*Fagus ferruginea*) had more than half their leaves closely rolled in from the sides by the pale yellow apterous form, the individuals of which were very nervous and active when disturbed. Each louse dragged about four long wavy threads of white secretion. No alate examples could be found. At City Park, Albany, a week later, the same species was seen infesting the underside of every leaf upon trees of the European beech (*F. sylvatica*) of both the green and purple varieties, but in no case were the leaves curled at all. I have never seen trees worse infested with plant lice than were these beeches. A few alate lice were taken at Albany. See figure 1.

Lachnus agilis Kalt. From pine leaves in City Park, Albany, New York. Both alate and apterous forms of this louse were taken. Lice very active and difficult to capture. *Winged viviparæ:* Body 1.70, wing 2.12, antenna 1.30, hind tibia 1.60 millimeters in length. Antennæ and all tibiæ set with numerous long stout hairs. For antenna and hind tarsus see figures 2 and 3.

Lachnus sp., near *agilis.* Taken at same place and date as the preceding on spruce. *Alate viviparæ:* Length of body 2.40, antenna 1.12, wing 3.30 millimeters; beak reaching well past 3d pair of coxæ; hairs upon tibiæ and antennæ more numerous than in case of *agilis* but the hairs are much weaker. Joint III with a single row of 4 tuberculate sensoria, IV with 1, V with 2. See figure 4.

Lachnus sp. A very small, powdery species rather common in rows upon pine needles at Washington, D. C. *Alate viviparæ:* Length 1.40, wing 2.34, antenna .90, hind tibiæ .86 millimeters; hairs of antennæ and legs long, pilose and rather abundant. Joint III of antenna with 8 sensoria; IV with 2; V with 1. See figure 5.

Melanoxantherium flocculossum Weed. Taken at Webster, Mass., and Portland, Ore., from the bark of willows. Both alate and apterous viviparæ. The peculiar weak cornicles, small at base, a

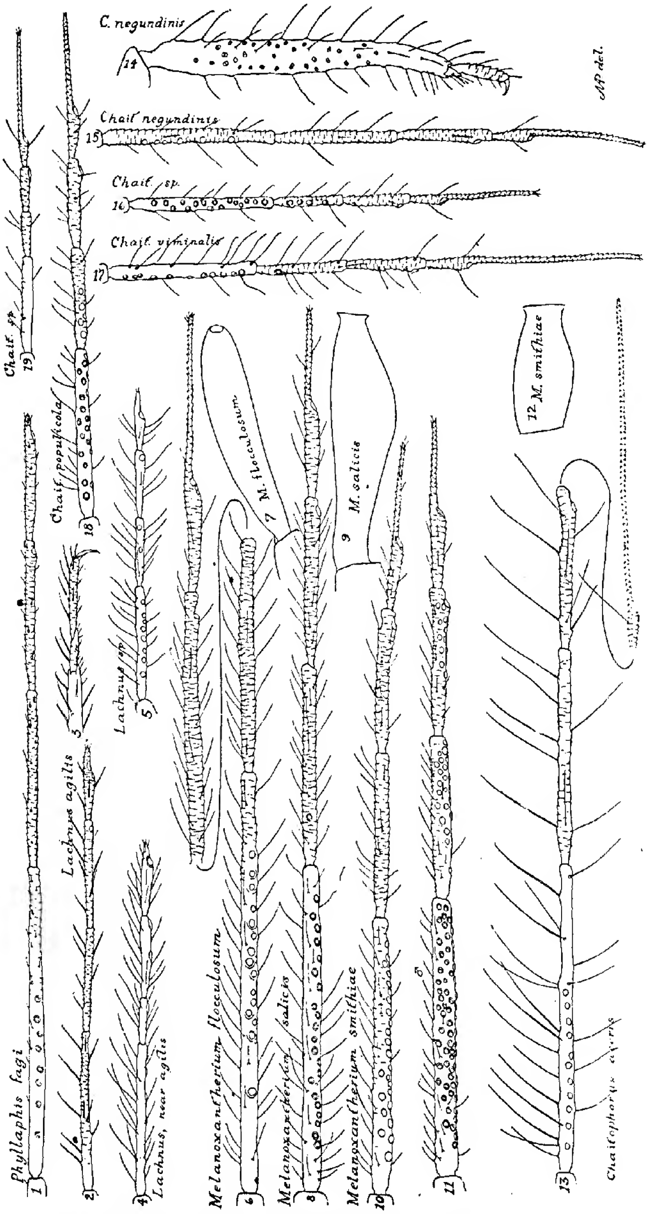

PLATE 13.—Some antennæ, cornicles and tarsi of aphids.

little larger in the middle and tapering to a rounded distal end entirely without flange, and the two longitudinal rows of conspicuous black spots upon the dorsum are striking characters of this large louse. It seems not to occur in Colorado. See figures 6 and 7.

Melanoxantherium salicis Linn. This species was taken by Mr. Bragg at Webster and Springfield, where it was feeding upon the bark of willows. Both alate and apterous viviparæ were in the lots taken. The only record we have for this species in Colorado is upon a few specimens taken by Mr. Bragg at Colorado Springs from willow. In general appearance this louse would be readily mistaken for *smithiæ* Monell. For characters of antennæ and cornicles of alate viviparæ see figures 8 and 9.

Melanoxantherium smithiæ Monell. This bark feeding louse was taken at Webster and Springfield where it was abundant on willow limbs. This is a very common species in Colorado, where it is always found feeding upon the small limbs. It is separated at once from any of the other species of this genus that I have seen by its very stout cornicles which are swollen in the middle and contracted at both ends. See figures 10, 11 and 12.

Chaitophorus aceris Linn. This species, so common upon the leaves of the sugar maple in the Central and Eastern states, I have never seen in Colorado. It was taken at Chicago, Lansing, Detroit, Geneva, Albany and Fort Lee. Both alate and apterous viviparæ were seen in each locality. See figure 13.

Chaitophorus negundinis Thos. This species, which is abundant upon boxelder, *Rulac negundo,* wherever the tree is planted upon both Atlantic and Pacific slopes in Colorado, was taken on this tree at Lansing, Albany, and Webster. Notice the peculiar double sensoria of the hind tibiæ of the oviparous female as shown in figure 14. The antenna of the alate viviparous female is shown at figure 15. The

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EXPLANATION OF PLATE 13.

1. *Phyllaphis fagi*, alate, Albany, July 1; 2 and 3, *Lachnus agilis*, antenna and hind tarsus, Albany, July 1; 4, *Lachnus*, near *agilis*, alate, Albany, July 1; 5, *Lachnus* sp., alate, Washington, July 3; 6 and 7, *Melanoxantherium flocculosum*, alate, Webster, July 16; 8 and 9, *Mel. salicis*, alate, Springfield, July 14; 10, 11 and 12, *Mel. smithiæ*, antenna of alate viviparæ, alate male and cornicle of alate viviparæ, Fort Collins, Colo., September 21; 13, *Chaitophorus aceris*, alate, Chicago, June 23; 14 and 15, *Ch. negundinis*, hind tibia of oviparous female, Fort Collins, November 16, antenna, Fort Collins, June 16; 16, *Chaitophorus* sp., alate viviparæ, Portland, Ore., August 22; 17, *Ch. viminalis*, alate, Georgetown, July 5; 18, *Ch. populicola*, alate, June 26; 19, *Chaitophorus* sp., apterous, Geneva, June 29. All figures enlarged 60 diameters. Original. Miriam A. Palmer, Delineator.

latter was taken November 16, and the former June 16 at Fort Collins, Colorado.

Chaitophorus sp. About Portland, Ore., and especially along the river from Portland to Oregon City, a species of *Chaitophorus* was common upon the leaves of the native vine maple, *Acer circinatum.* The lice seen were mostly apterous viviparæ and dimorphs. The latter were distributed along the main veins of the leaves and upon the wings of the fruit. Most of the dimorphs were decidedly yellow in color but some were growing preparatory to molting and these were quite dark, almost black. Some small very dark lice upon the leaves were probably shed dimorphs.

The apterous viviparæ are very similar to *negundinis* in general appearance except that they are almost black in color.

This louse is certainly not *negundinis* and I can not make it seem possible that it is *aceris.* The antenna is shorter and the filament much shorter in proportion (see fig. 16) and I can not find more than 20 flabellæ in any of the dimorphs, the more common number seems to be 18, or even 16.

Chaitophorus viminalis. At Chicago, Geneva, Webster and Georgetown, both alate and apterous viviparæ were taken upon willow leaves. This species was specially abundant at Geneva. It is an abundant species in the vicinity of Fort Collins almost every year. This species seems to be separated from closely allied forms by the unusually long antennal filament. See figure 17, which shows the antenna of an alate female.

Chaitophorus populicola. Taken at Portland, Michigan and Fort Lee on aspen, *Populus tremuloides.* This is a very abundant species in Colorado, at least to 9,000 feet altitude, upon the cottonwoods and aspens. Upon the aspens in the foothills the apterous viviparæ are almost entirely shining black in color. They often attack the tender ends of twigs in such numbers as to kill both the leaves and new growth. See figure 18.

Chaitophorus sp. A small yellowish green *Chaitophorus* with head a little dusky, was fairly common upon the under side of the leaves of *Malva rotundifolia* on the grounds of the Experiment Station at Geneva. Apterous viviparæ only were seen. The body length varies between 1.10 and 1.25 mm, and the antennæ between .77 and .90 mm in the specimens taken. The species seemed rather sporadic in habit. The antenna of an apterous female is shown at figure 19.

A NEW INSECTARY

By E. Dwight Sanderson, *Durham, N. H.*

At the last annual meeting of the Association of Economic Entomologists[1] the writer led a discussion as to the necessity of a glasshouse insectary for most life history studies. Although appreciating the necessity of a glasshouse for purposes of instruction and for certain classes of entomological investigations he has felt for some time that a structure which would give more natural conditions would be much preferable for most life history work. Carrying out this idea, an insectary was erected by the New Hampshire Agricultural Expermiment Station during the past summer, which is illustrated herewith, and whose construction may be of interest.

It was necessary to build the house on a side hill so that some filling was required and the outer end of the house is several feet above the surrounding area. This is a disadvantage which should be avoided where possible. A stone wall foundation, eighteen inches deep by twelve inches thick, was laid for the base of the entire house, which is thirteen by twenty-four feet. At the head end is a permanent wooden workroom, six by thirteen feet. A door enters from outside on the east side and another opens to the rearing room on the south side. On the north and west sides are windows. This gives ample room for one or two work tables, shelves, storage, etc. The walls are made of seven-eighths boards one foot wide, with three inch battens over the cracks, and the roof is covered with a gravelled roofing paper. All windows and doors are screened.

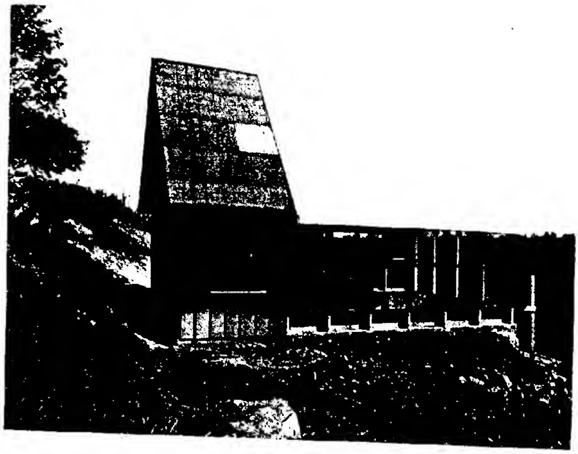
The rearing room has a cement floor through the center, with six cement pits down one side, and a strip of soil two feet wide along the opposite wall. The floor slants so that water runs out through a drain at the further end. The inside of each pit measures about two feet eight inches square and the outer walls are eighteen inches high. There are no bottoms to the pits so that when filled with soil they are continuous with the soil beneath. The sides of the rearing room are composed of 18-mesh, bronze screens, three feet wide and five feet high, resting on a cement coping, which are buttoned to the uprights which support the roof. The uprights of the sides are bolted to the cement coping and the framework for the roof is fastened together with bolts and screws, so that the whole structure may be taken down, stored for the winter, and readily erected again in the spring. The canvas roof is double, the ridge of the lower one being

[1]Jour. Econ. Ent., II, 59.

about eight feet above the floor and the outer one about eleven feet, giving a one-half pitch. The outer roof is of the heaviest sail cloth, while the inner is of twelve ounce canvas. This arrangement prevents any leaking through the outer roof, on account of the strong pitch, and cuts out the heat of the sun, by the air current between the two. The lower roof also protects the upper from the strain of the wind coming through the screen sides. At the outer gable end the gable is covered by canvas down to the screens. Each roof is really a fly, with a broad seam on each side through which a strip is run and is then screwed to the sides, thus affording a means of tightening the roof should it stretch. After four months, with many heavy winds, the roof shows no signs of wear. The spaces between the upright supports for the roof are filled in between the roofs so that the rearing room is absolutely tight for all ordinary insects too large to pass through an 18-mesh screen.

It is believed that this house affords as nearly natural conditions as possible consistent with an enclosure. Insects which pass the winter in the soil may be reared in cages placed on the pits or in cages on the soil side of the floor, and left there throughout the winter under normal conditions and cages then placed over them when the house is erected in the spring. Many of the details of construction, and indeed the whole house, must be regarded as an experiment, but from the experience of the Bureau of Entomology with more temporary structures in their work at the Gypsy Moth Laboratory at Melrose Highlands, Mass., it is believed that the general principles upon which the house is based are worthy of such a trial as they will now have.

The whole structure cost approximately $400. Of this nearly one-third was for the grading and cement work. About one half of the total cost was for labor and one half for materials. The double roof cost $47. The screens, including two doors and two window screens for the workroom, with the sixteen around the rearing room cost $70. Lumber cost about $50. Where no gradings were necessary and where a house could be built from plans previously developed, ours developed as we progressed, such a house could probably be built for $300. We shall be glad to furnish any further details of structure to any who may be interested.



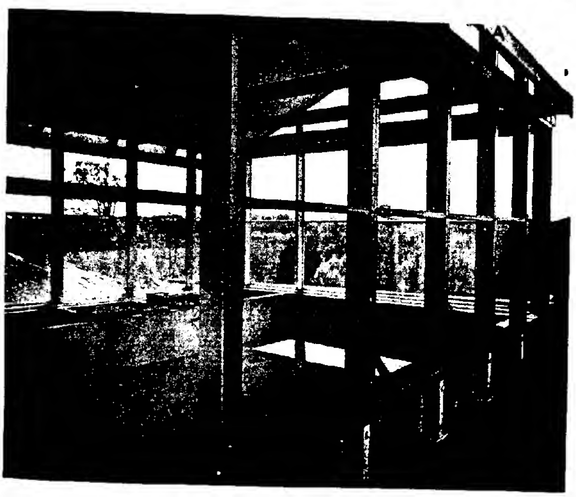


PLATE 14.—Insectary building of New Hampshire Agricultural Experiment Station. A and B strips passing through seams of canvas of upper and lower roof.

THE OBLIQUE-BANDED LEAFROLLER

Archips rosaceana Harris[1]

By E. Dwight Sanderson and Alma Drayer Jackson

In July, 1909, our attention was called to a case of very serious injury caused by the Oblique-banded Leafroller in a large rose house at Madbury, N. H. This is one of the largest rose conservatories in the country, the two houses having a total length of nearly one-half a mile and covering three acres. The roses on one or two benches had been entirely defoliated for over 200 feet as shown in Plate 15. Brief reference to entomological literature gave practically no information of value concerning the pest, so that an investigation was commenced at once. Mrs. Jackson kindly took entire charge of the rearing work and is responsible for the account of it, while the senior author is responsible for the rest of the present article.

History

This insect is an interesting example of one of our best known and much be-written species about which there seems to be but little information. Among the sixty-eight references given in the bibliography, less than a dozen give any very original information of any importance. The great bulk of the literature is mere compilation and quotation from Harris, the original describer. Coquillett seems to have made the most observations upon the species, but not until 1903 were the eggs briefly mentioned by Hart, and no one seems to have observed the stage which passes the winter. The insect has been a common one thruout the United States and, as the bibliography shows, has been noted for over half a century wherever entomologists have been located.

Injury

Serious injury by it has, however, been only occasionally reported. In 1894 Fletcher reported injury to the foliage and young fruit of pears in Ontario. In 1895 Piper noted considerable injury to prunes in Washington. In 1896 Lintner recorded serious injury to apple foliage and by the larvæ gnawing into young apples in eastern and central New York. The same year Lugger reported that Russian apples are sometimes defoliated by the caterpillars in Minnesota. No very serious injury to roses was noted until Chittenden in 1903 mentioned a case in which roses received from Ohio at Libonia, Pa., in

[1]Moths were determined for us by the courtesy of Prof. C. H. Fernald.

May, 1898, were badly infested, though Smith (1896), Davis (1897), and many others had mentioned the rose as one of the common food plants.

In the case under our observation the pest was received on some Killarney plants imported from an Ohio firm something over a year ago. The larvæ evidently increased during the summer of 1908 and by midsummer of 1909 were sufficiently abundant to cause very serious devastation, the loss from defoliation and incidental checking of blooms undoubtedly amounting to over five thousand dollars. Fortunately the infestation started in one corner of the house and though when first observed by us both houses were well infested thruout, defoliation was confined to a relatively small area and the slowness of the spread was rather remarkable. When first observed most of the terminals had been folded up by the larvæ. Subsequent observations show that where the larvæ are not numerous that they are much more common on the lower leaves than on the terminals, this doubtless being due to the fact that the eggs are always laid on the older leaves and never on the terminals. Where plants are badly infested the larvæ tie the terminal leaves together in a typical tortricid fashion, thus checking all growth of the plant, and burrow into the flower buds, so that there is no possibility of securing blooms (Plate 16).

The owner of these houses states that some twenty years ago he was troubled with the same insect in rose houses in Massachusetts, but not so seriously and it was gradually brought under control by handpicking. Upon visiting the Waban Rose Conservatories at Natick, Mass., Mr. Alex. Montgomery, the manager, informed the writer that some twenty years ago when hybrid roses were first introduced that they had had considerable trouble with the insect both in the house and on Jacqueminot roses growing out of doors, but that in recent years, though a few were always to be found in old houses, they had found no difficulty in controlling them by handpicking. Mr. Montgomery had just returned from an extensive trip among rose growers thruout the East, but had heard of no noteworthy damage by the insect in recent years, nor do the florists' trade journals give any account of injury, except that Sirrine (1900) mentions it as a carnation pest, where carnations are with or follow roses, implying that it a common rose pest. It is evident, therefore, that serious injury to roses is sporadic as on the apple, and other common food plants.

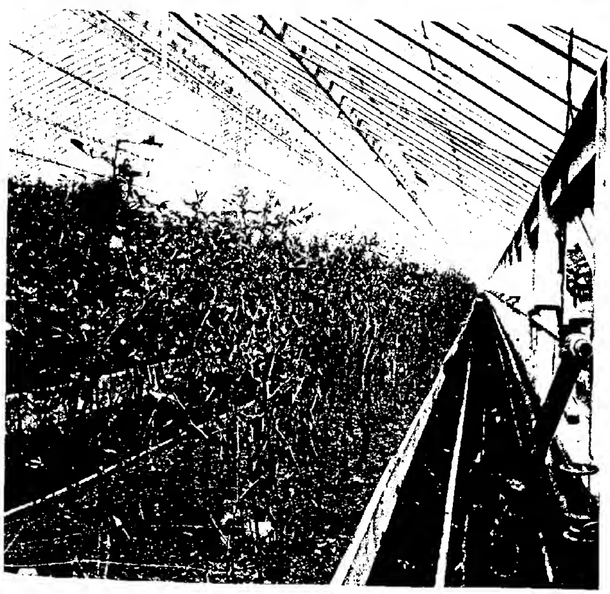


PLATE 15.—Injury in rose house by the Oblique-banded Leaf-roller. The upper view shows the complete defoliation of the plants on the benches seen in the lower view. Photos by W. S. Abbott.

PLATE 16.—Showing injury to terminals and buds of rose by the Oblique-banded Leaf-roller. Photos by W. S. Abbott.

Food Plants

The list of food plants on record comprises over fifty species, as follows:

Gnaws rinds of apples (Walsh & Riley); currant (Perkins); oak (Hart); cotton (Glover, Mally); rose, apple blossoms and leaves, peach, cherry, yellow birch, plum, clover, honeysuckle, beans, strawberry, *Acer negundo, Crataegus, Cornus stolonifera* (C. H. Fernald); *Betula populifolia* (Packard); ash (Forbes); celery (Davis); pear,—leaves and fruit, gooseberry, black currant, garden geranium, silver maple seeds (Fletcher); plums and prunes (Piper); apple—foliage and young fruit (Lintner); Russian apples defoliated (Lugger); roses (Smith, Davis); blackberry (Chittenden); carnations (Sirrine); basswood (Gibson); bred from apple, cherry, Siberian crab-apple, lilac, horsechestnut, raspberry, wild strawberry, wild rose (*Rosa blanda*), burdock (*Lappa officinalis*), thistle (*Circium lanceolatum*), red clover, ragweed, smartweed, knot grass (*P. aviculare*), and found on burr-oak, poplar, hazel, sumac, wild raspberry, wild blackberry, horse radish, wild sunflower (*Helianthus grosseserratus*) and blue vervain (*Verbena hastata*)—Coquillett; elm, beech (C. H. Fernald, mss.).

Distribution

C. H. Fernald gives the distribution as from Maine to California. Dyar gives Northern United States and Colorado. It undoubtedly occurs thruout the United States as the following records indicate. Maine (Harvey, Packard); Massachusetts (Harris); Ontario (Fletcher et al); New York (Lintner); Pennsylvania, Florida, Texas (Robinson); Kansas (Snow); Nebraska (Bruner); Michigan (Cook); Illinois (Coquillett); Minnesota (Lugger); Washington (Piper); Texas (Mally).

Life History

The larvæ appear in spring and attack the young foliage of the apple as soon as it opens, and later the blossoms and young fruit, as originally described by Harris and by numerous subsequent writers. In the northern states the larvæ mature during June. Coquillet is the only writer who has recorded the length of the pupal stage and gives five to sixteen, average nine days, in Illinois. The moths emerge from May 30 in Delaware, as observed by us, until early July in New England. Dates of emergence of moths as recorded are as follows:—Massachusetts, end of June (Harris); Maine, last of July (Harvey); Vermont, early July (Perkins); New York, July 1 (Fitch), at light June 13 (Lintner); Michigan, mid-June (Cook);

Illinois, late June, early July (Hart, Coquillett). Chittenden secured pupæ and moths from Libonia, Pa., May 3, 1898, but these were from greenhouse roses.

The eggs have been mentioned only by Hart, who states that the eggs overlap in flat masses. Emmons stated that on plum the eggs were laid in patches on the bark in June and July and remain there until the next spring, but as he expresses a doubt as to whether the species was really *rosaceana*, there seems no good reason to give credence to this observation, which probably refers to *A. cerasivorana* which has such habits.[1] A second brood undoubtedly occurs thruout the range of the species. Cook mentions a second brood of larvæ in autumn, observing a larva as late as October 5, and Harvey and Hart mention a second brood of larvæ in August. Coquillett reared moths of a second brood in late July and until mid-August in Illinois. Packard reared a moth September 1 in Maine and Harvey states they occur the last of July. Moffat found moths abundant at London, Ont., in late July and early August, and Snow in Kansas on August 9.

A second brood of moths thus give rise to larvæ which work in the fall. Coquillett hazarded the guess that the eggs passed the winter, but this is the only statement as to the hibernation except that Harvey was candid enough to state that nothing was known of the eggs or hibernation of the species. From the fact that the larvæ occur in fall and early spring and that many species of this family pass the winter as larvæ it seems probable, though we have no definite observations on the point, that the larvæ hibernate over winter probably within folded leaves well encased in their own silk, either attached to the tree or on the ground, altho they may hibernate under or attached to the bark. It seems probable that even in a warm greenhouse the majority of larvæ do not transform in the winter, as Mr. Montgomery of Natick, Mass., states that they have never been troubled with them in winter, but that as soon as the spring sunshine warms up the houses they commence to work. We are now making observations on this point. It will be interesting to determine, as we expect to do, whether more than two generations occur in greenhouses, but our present data does not so indicate.

Observations on the Life History

The following observations on the life history were made during August and early September, 1909. The eggs are laid in round or

[1]Weed. Bulletin 81, N. H. Agr. Exp. Sta., p. 17.

oval, flat, green patches, each containing an average of about 117 eggs, as shown below.

Number of eggs:	10–20.	25–50.	75–100.	100–150.	150–200.	275.	300.	360.
Number of masses:	7.	6.	5.	3.	4.	2.	3.	1.

The table shows plainly the great variance in the number of eggs in one mass, ranging as it does from a very few to over 300. A weighted average of the above gives 117 eggs as the average number laid at one time.

The total number of eggs produced by one pair of moths is an interesting as well as an important feature. For this purpose, single pairs of moths which had just emerged, were isolated and placed in glass cylinders containing fresh rose twigs. As soon as the eggs were noted they were removed and counted. The results were as follows:

Number of eggs laid by individual females: 650, 488, 80, 375, 52, 83, 200, 575, 190, 45, 400, 575.

Averaging the above gives 305 eggs to be the average number laid by one female moth at room temperature having a mean of 70°F. The masses vary considerably in size, four millimeters being a good average width. The eggs are glued together by gelatinous material and often overlap. From our observations in the infested greenhouse and in the insectary they are generally deposited on the older leaves of the plant rather than on the fresh shoots. The egg mass is usually a shade lighter than the green leaf. Oviposition usually takes place at night, although cases have been observed on very cloudy days. Practically all the eggs of a mass hatch at once, leaving the empty shells of the mass whitish in appearance. In case of parasitism the individual eggs are blackened by the pupa of the parasite. The figure in Plate 17 above E is a parasitized egg mass, while the light masses are unparasitized.

The time of incubation varies considerably according to the temperature. A number of freshly deposited egg masses were put in vials and placed in an incubator kept at 80°F. The length of the egg, larval, and pupal stages were all determined with specimens kept in a glassfront incubator kept constantly at 80°F., which is practically the mean temperature of the rose house in summer. Observations were made every morning from which were obtained the following data:

Number days' incubation	5	6	7	8	9
Number of egg masses	10	12	11	9	4

From the above experiment 6.67 days is found to be the average

length of time required for the incubation of one egg mass at what is probably an average mean temperature for a rose house in late summer. Another lot of egg masses was left in the room where the temperature averaged 70°F. From these we obtained the following results:—

Number days' incubation	8	9	10	11	12
Number of egg masses	1	6	6	6	3

At this temperature a single egg mass requires 10.18 days incubation and so takes 3.51 days longer to hatch at 70° than at 80°F.

The larvæ when first hatched are extremely minute and closely resemble the leaf in color. They crawl about for three or four days, feeding here and there and growing rapidly. At the end of this period the young larva begins to form a protection for itself by pulling two or three leaves together, or more frequently a young larva will fold over a single leaf forming a tube open at either end. The leaves are held together by silken threads. The larva feeds upon the inside of the tube or makes short excursions to adjacent leaves which are pulled down and attached to the original tube, so that as the larva increases in size it also increases the size of the nest. It was frequently observed that when all the leaves of a particular part of a plant had been destroyed the larvæ would go to another part of the plant and start new nests. This, however, seems to be dependent on food supply. The length of the larval stage may be seen from the following:—

Larval period in days	22–25.	26–29.	30.	31–35.	36–40.	41–46.
Number of larvæ	11.	16.	13.	28.	14.	9.

The average length of the larval stage is thus 32.69 days at 80°F. There is no doubt but that food conditions may very materially influence the length of the larval stage which is probably somewhat shorter than the above figures indicate. Before pupation the larva draws the leaves together more firmly than usual so that they practically form a cocoon, to the silk of which the pupa is attached by the hooks of the cremaster. The average length of the pupal stage may be seen from the following:—

Pupal period in days	5	6	7	8
Number of pupæ	13	23	23	9

This gives 6.41 days as the average of the pupal stage at 80°F. Out of 62 pupæ, 35 were males and 27 females. About 30% of the pupæ failed to transform.

The adults emerge during the night and if not disturbed will remain in the vicinity of the pupal cases throughout the following day. Usually the males may be distinguished from the females not only by their smaller size but also by two round black spots on the thorax (Plate 17, B). Mating occurs shortly after emergence. The length of time between emergence and egg deposition may be seen from the following:—

Days from emergence to oviposition....	1	2	3	4	5	6
Number of females....................	1	2	2	4	1	1

Thus on an average a female oviposits at the end of 3.45 days at the room temperature of 70°F. Egg deposition may not, however, all occur at once, as one moth may deposit several egg masses at different times. The average life of an individual as seen from the following is 14.6 days at 70°F:

Length of life in days..........	11	12	13	14	15	17	20
Number of moths...............	2	6	2	2	2	2	4

Summarizing the life history it is found that at a constant temperature of 80°F. the egg stage is 6.67 days, larva 32.69 days, pupa 6.41 days, and life of moth to oviposition 3 days, giving a total of 48.77 days or seven weeks. The difference in rate of development of the eggs at 70°F. would indicate that the total life cycle at 70° would require over ten weeks. This is about the temperature of a rose house in this latitude in September. After October first the houses have a mean of about 62°, running from 56° at night to 70 to 75° in the day. With this temperature the life cycle would probably require three to four months.

Description

Egg mass. (Plate 17, E.) Round or oval, flat, green patches, generally lighter green than the leaf; laid very close together, frequently overlapping; held together by glutinous material; average number in mass, 117; varying in size from a small dot to one-fourth by one-half inch.

Larva. (Plate 17, F). Generally light green in color, varying in some specimens to a reddish or brownish green; a darker green stripe generally evident along the dorso-mesal line; head round, very dark brown or black mottled with brown; mouthparts lighter brown; anterior portion of clypeus light brown; anteclypeus greenish white; labium green with the exception of the distal portion and a black triangular spot near the base; labial palpi green, first and basal segment black; antennæ of three segments; tip of antennæ dark brown,

base green; cervical shield brown or greenish brown, posterior border black, a very distinct dorsal suture lighter; two black tubercles on either side midway between ventral border of cervical shield and prothoracic legs, each provided with two long setæ; prothoracic spiracle posterior to the dorsal tubercle; thoracic legs black, first segment concolorous with body; prolegs and anal legs green; anal shield concolorous with body; spiracles circled with brown on each abdominal segment; third to sixth abdominal segments bearing prolegs; yellowish tubercles as follows,—abdominal segments one to eight bear subdorsal tubercles I and II, with single seta, I mesad of II, III just above spiracle and IV–V just below spiracle, VI, VII and VIII as usual; on segment nine II is nearer the meson than I and lies close to the caudal margin, and III just latero-caudad of II; anal segment bears three large sub-dorsal setæ on the caudal half, and a lateral seta on each side; meso- and meta-thorax with a sub-dorsal tubercle bearing two setæ (I), another further latero-cephalad (II), a tubercle with two setæ (III–V ?) in the usual position of the spiracle, and one just caudad of this bearing a single seta (IV); a tubercle in the same position as VI of the abdominal segments further ventrad and apparently homologous; VII and VIII as usual.

Pupa. (Plate 17, C). Light brown just after pupation, becoming much darker with age; lighter on ventral surface; a mid-dorsal dark line beginning with the thorax running the length of the body; the anterior and posterior margins of abdominal segments I to VII inclusive bear a row of short black spines or teeth on both anterior and posterior margins; yellowish setæ are scattered over the body; a decided blackish cremaster nearly twice as long as broad, about equal to the eighth abdominal segment in length, rounded at tip, bearing two strong hooked spines at the tip and one on either side near the tip.

Moth. (Plate 17, A. B.) See Robinson and Clemens (1860) in bibliography.

Natural Enemies

Parasites. It is evident that this species is most effectively held in check by its natural enemies or with so large a list of food plants, wide distribution, and the number of eggs laid, we should have frequent serious outbreaks. What little evidence we have points to the fact that it is held in check by parasites. Coquillett (1882) states that a species of *Glypha* emerges from the larva about the time it should pupate and spins a cocoon from which the parasite emerges 8 to 12 days later; and that in late August, fully one half of the larvæ

Plate 17.—A, female moth; B, male moth; C, pupæ; D, moth at rest on foliage, natural size from life; E, egg masses, the one immediately above E full parasitized, the next partially and the one at right unparasitized; F, larvæ—all greatly enlarged. Photos by W. S. Abbott.

are thus parasitized. On some larvæ he observed Tachina fly eggs, and *Perilitus limidiatus* Cresson was reared from one pupa. Cook found that *Glypta simplicipes* Walsh was a very effective parasite of the larvæ and also reared *Microdus laticinctus* from one. Snow reared an unknown tachinid from a larva. Lugger mentions the Baltimore Oriole as a particularly effective enemy of the larvæ.

The outbreak observed by us furnished a case of the most complete parasitism we have ever seen. When first observed in late July from one third to one half of the eggs were parasitized by a species of *Trichogramma*. Two weeks later it was difficult to find an egg mass in which over 95% of the eggs did not contain the black pupæ of the parasite and in most cases 99 to 100% were affected. So effective were the parasites that the control of the outbreak was undoubtedly due to them much more than to any remedial measures.

Remedial Measures

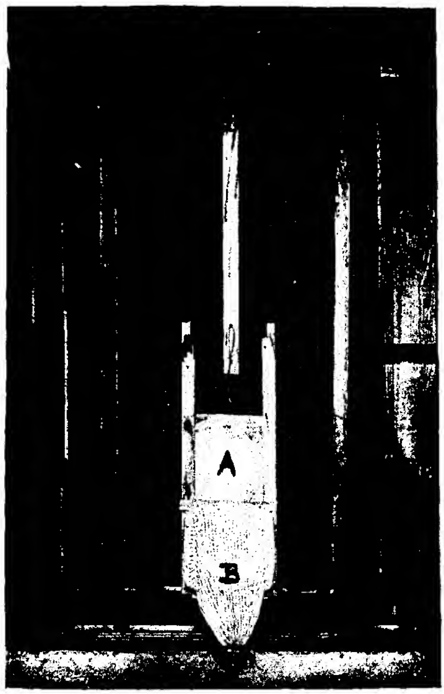
Spraying with arsenate of lead was at once advised by us in the greenhouse above mentioned. The owner hesitated to apply it, however, as it would spot the foliage so as to prevent the sale of any possible blooms, and requested that we experiment with fumigation.

Fumigation. Experiments were, therefore, made at once with hydrocyanic acid gas. For this purpose we had a large box constructed which fitted just inside a window-frame of the insectary workroom. (Plate 18.) This was fastened tightly to the frame, was covered with sheathing paper, all cracks stopped with putty, and the crack between the window sashes plugged with cotton. Thus the box was fully as tight as the average greenhouse. By raising the window from the outside, potted plants could be placed within to test the effect on them and the box could be quickly ventilated. On the inside, a tightly sliding door was fastened and over the opening to the box a canvas sleeve, which was tapered and constricted by an elastic band at the end. With this arrangement, the plants, insects, and acid could be placed in the box through the window on the outside, everything made tight, and the cyanide then poured in from the inside with no possible escape of gas. Furthermore, at any time by inserting one's arm in the sleeve, the sliding door could be raised, a tube containing insects removed, the door then shut, and the tube taken out and subsequently returned in the same way, with practically no loss of gas, thus enabling one to accurately observe the effect on the insects after different lengths of time by having several tubes of insects and taking them out at intervals. The first experiment was made with cyanide at the rate of one ounce to 1200 cubic feet, a rate

often used against aphides by allowing the gas to remain in the house over night, during which time it usually leaks out. In each case several tubes, each containing several specimens of all stages of the insect were used. Though one or two moths and occasionally a larva were killed after three hours exposure, many were alive the next morning, the gas having been generated about 6 p. m. The strength was then doubled to one ounce cyanide to 600 cubic feet, then doubled again, and finally doubled again to one ounce to 150 cubic feet without killing the majority of the larvæ or moths in an hour's exposure, but seriously injuring the plants at the latter strength. Mr. H. F. Hall, formerly horticulturist of this station, who has had extensive experience in greenhouse fumigation, tried similar experiments in a small greenhouse in Massachusetts with the same results. All further experiment with fumigation was therefore dropped.

Arsenate of Lead. Arsenate of lead was then applied to all the plants in the affected houses at the rate of three pounds to the barrel. Many of the worst infested plants were first cut back. This was applied in a novel, but exceedingly effective and practical manner. The tank in which manure water is mixed and the pipes leading from it to all parts of the houses, were flushed out. The arsenate of lead was then mixed up in the tank, hose was attached at each outlet in the houses and when all was ready a score of men commenced spraying, and in an hour and one half the three acres of plants had been thoroughly sprayed without the use of a pump. The application was repeated about a week later. Inasmuch as the eggs are laid on the old foliage and the young larvæ feed upon it, there can be no doubt of the efficacy of arsenate of lead, but its effect was obscured in this case by the almost total parasitism of the eggs. Nevertheless, it probably aided greatly in killing off larvæ and those which hatched from the few unparasitized eggs, for on November 17 larvæ could still be found in some numbers on individual plants here and there. It is questionable whether spraying with arsenate of lead would be desirable on roses except in cases of serious infestation, owing to the spotting of the foliage, but this might be avoided by dusting with dry arsenate of lead. Paris green, dry and sprayed, with and without lime, has been tried by growers in the past, but there is always danger from burning the foliage.

Handpicking. There seems to be no reason why the pest cannot be entirely controlled in rose houses by reasonable diligence in handpicking. This has been practiced for years in some houses where the insect occurs but has never become numerous enough to cause trouble. From our observations we feel that there can be no doubt that hand-



A, sliding door, and B, sleeve over opening to box.
PLATE 18.—Fumigation box seen from inside workroom.

picking so that the insect is never allowed to become abundant enough to warrant spraying or dusting, is by all means the most practical method of control in rose houses. With the removal of the plants and thorough fumigation of the empty houses the pest may thus be easily controlled.

Trap Lights. When the injury was worst, the moths were flying about the house by hundreds, could be picked up beneath every plant, and could be found beneath the benches in the shade in large numbers, often several within a few inches of each other. The owner having observed their attraction to lights, trap lanterns set in pans of water were placed thruout the houses and very large numbers of moths were caught. These lights have been continued during the fall and by the middle of November, fifteen to twenty moths per night were usually caught in the larger house. There can be no doubt of the efficacy of trap lights for this insect in a greenhouse.

For the control of the insect upon apples and other orchard trees, cane and small fruits, and its numerous other food plants, there would appear to be no reason why a thorough application of arsenate of lead to the young foliage and again in midsummer at the time of the emergence of the second brood, should not control it entirely. The determination of its hibernating habits and measures to destroy it in hibernation might also be of value.

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THE GEOGRAPHICAL DISTRIBUTION OF AMERICAN TICKS

By W. A. Hooker, *Washington, D. C.*

In the fourth part of the last memoir of his revision of the ticks, published in 1901, Prof. L. G. Neumann considers their geographical distribution, the species being brought together under the various political divisions of the world in which they are known to occur. The North American species listed are largely based upon the Marx collection of the United States National Museum and the collection of the Bureau of Animal Industry of the United States Department of Agriculture.

Since this account was published there has been an increased activity in the collection of ticks in this country which has resulted in the discovery of many new forms and of a wider distribution of the species recorded than was then known. In Neumann's "Notes sur les Ixodidés," which have followed the "Memoirs," new records have been given which include data on American species. With the appearance of Banks' Revision of the ticks of this country, several new species were described and a number of names were relegated to synonyms through the recognition of Say's and Packard's species. In preparing his "Revision," Mr. Banks examined the collection of the Museum of Comparative Zoölogy, which contains Packard's types,